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Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

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В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными

возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением, Благотворительный Фонд «Халык»!

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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MODERNIZATION OF CRUSHING AND MILLING EQUIPMENT USING PNEUMATIC CHAMBER STARTING-AUXILIARY DRIVES

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Abstract. At the enterprises of the mining and metallurgical complex, there is a problem of starting equipment with a heavy rotor. The article is devoted to the analysis of the causes of heavy start-up due to high impulse currents, and related problems of ore-grinding units, such as failure of the electric motor, increased operating costs for electricity, etc. The keys are proposed to solve not only these problems, but also the problems associated with reducing downtime when replacing the lining. The possibilities of a pneumatic chamber ratchet drive as an auxiliary starting drive of ore-grinding units are discussed. A pneumatic chamber ratchet drive was developed and studies were carried out, according to the results of which the possibility of using it as an auxiliary starting drive of ore-grinding units was determined.

Keywords: ball mill, relining, impulse currents, backlash, auxiliary, pneumatic chamber, ratchet

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ПНЕВМОКАМЕРАЛЫҚ ІСКЕ ҚОСУ-КӨМЕКШІ ЖЕТЕКТЕРДІ ПАЙДАЛАНА ОТЫРЫП, ҰСАҚТАУ-ҰНТАҚТАУ ЖАБДЫҒЫН ЖАҢҒЫРТУ

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Аннотация. Тау-кен металлургия кешенінің кәсіпорындарында ауыр роторлы жабдықты іске қосу проблемалары бар. Мақала ауыр іске қосу себептерін және жоғары іске қосу токтарын және электр қозғалтқышының істен шығуы, электр энергиясының пайдалану шығындарының жоғарылауы және т.б. сияқты рудалық агрегаттардың байланысты мәселелерін талдауға арналған. Пневмокамералық қырылдақты жетегінің кен ұңтақтау агрегаттарының қосалқы іске қосу жетегі ретіндегі мүмкіндіктері талқыланды. Пневмокамералық қырылдақты жетегі әзірленді және зерттеулер жүргізілді, оның нәтижелері бойынша оны кен ұсақтау агрегаттарының қосалқы іске қосу жетегі ретінде пайдалану мүмкіндігі анықталды.

Түйін сөздер. шарлы диірмен, қаптаманы ауыстыру, іске қосу тогы, люфт, көмекші, пневмокамералы, қырылдақты

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МОДЕРНИЗАЦИЯ ДРОБИЛЬНО-РАЗМОЛЬНОГО ОБОРУДОВАНИЯ С ИСПОЛЬЗОВАНИЕМ ПНЕВМОКАМЕРНЫХ ПУСКО-ВСПОМОГАТЕЛЬНЫХ ПРИВОДОВ

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Аннотация. На предприятиях горнометаллургического комплекса существует проблема пуска оборудования с тяжелым ротором. Статья посвящена анализу причин тяжелого пуска из-за высоких пусковых токов, и связанных с этим проблем рудоразмольных агрегатов, таких как выход из строя электродвигателя, повышенные эксплуатационные затраты на электроэнергию и т.д. Предложены ключи для решения не только этих проблем, но и проблемы, связанные с сокращением простоя при замене футеровки. Обсуждены возможности пневмокамерного храпового привода в качестве вспомогательного пускового привода рудоразмольных агрегатов. Был разработан пневмокамерный храповой привод и проведены исследования, по результатам которых определена возможность использования его в качестве вспомогательного пускового привода рудоразмольных агрегатов.

Ключевые слова: шаровая мельница, замена футеровки, пусковой ток, люфт, вспомогательный, пневмокамерный, храповой

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Introduction

The enterprises of the mining and metallurgical complex (MMC) operate a significant number of technological machines with a heavy rotor. Because of their large inertial mass, the most unfavorable operating modes are starting modes, in which the loads

on the starting devices are repeatedly exceeded, and this reduces their resource and leads to frequent failures [2, 8, 12]. The relevance of research in this direction lies in the optimization of the starting modes of drum mills and the use of original auxiliary devices with a high torque, which will significantly reduce the load on the main standard drive devices of heavy rotary equipment at starting modes [1, 9].

The article provides an analysis of heavy start-up and the related problems of ore grinding units, keys are proposed for solving not only this problem, but also the problems associated with reducing downtime during relining. The possibilities of a pneumatic chamber ratchet drive as an auxiliary starting drive for ore-grinding units are discussed. However, it turned out that today only electromechanical equipment is used in production, including as an auxiliary starting drive for various rotary equipment. A significant part of scientific research carried out in recent years in the world was mainly aimed at wider application of the capabilities of a variable frequency drive (VFD) [11], optimization of start-up parameters [1-6] and modernization of the auxiliary electromechanical drive [19, 23].

Pneumatic drives were previously used by the Institute of Mining named after A.A. Skochinsky (Lyubertsy, RF), their research is devoted to the introduction of pneumatic drives into equipment and machines of the underground cycle, for the modernization of mine excavation machines [7]. However, to date, none of the research projects, there is data on the introduction of pneumatic drives as an auxiliary starting device for machines with a heavy rotor [5, 6].

The article substantiates an approach for using a pneumatic drive in the start (acceleration) mode. The criterion is the choice of clearances and the reduction of static friction forces. As a result of preliminary studies, the design of the auxiliary starting device is presented, which is distinguished by its simplicity of design and the possibility of manufacturing by the repair-mechanical base (RMB) of the enterprise.

Methodology (Model)

The auxiliary drive, which can be electric, hydraulic or pneumatic, is designed to ensure the rotation of the rotor when starting the equipment or when a low number of revolutions is required (during repair work and work related to relining) [14-16]. Due to the difficult start-up conditions and the accompanying frequent repairs of the mill, the operating organization, even in the absence of raw materials, prefers not to stop them, so they work without load for a long time. Electricity consumption in such a mode of unproductive work can exceed the cost of introducing new technical solutions within 1–2 years. At high drive powers of a ball ore-grinding mill (Figure-1 BMOG, power from 400 kW and more) with low speed (13 rpm), the engine design reaches enormous dimensions. The starting currents can be several times higher than the nominal ones required in normal stable operation, and the starting time is quite long, as a result of which the drive cannot withstand a large number of starts, and also there are significant voltage drops in the supply network. Considering that at large enterprises (mining and processing enterprises) the number of such mills reaches many tens, it is easy to imagine problems with the supply network at the enterprise and the total cost of repairs to mill drives caused by direct starts.

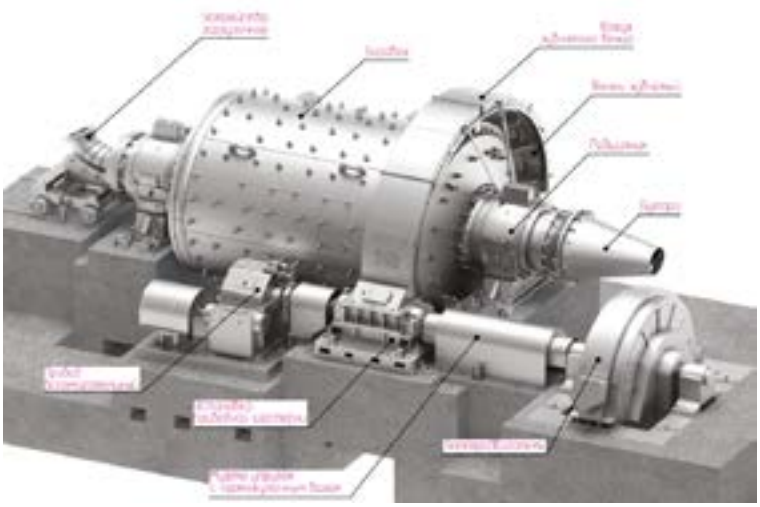
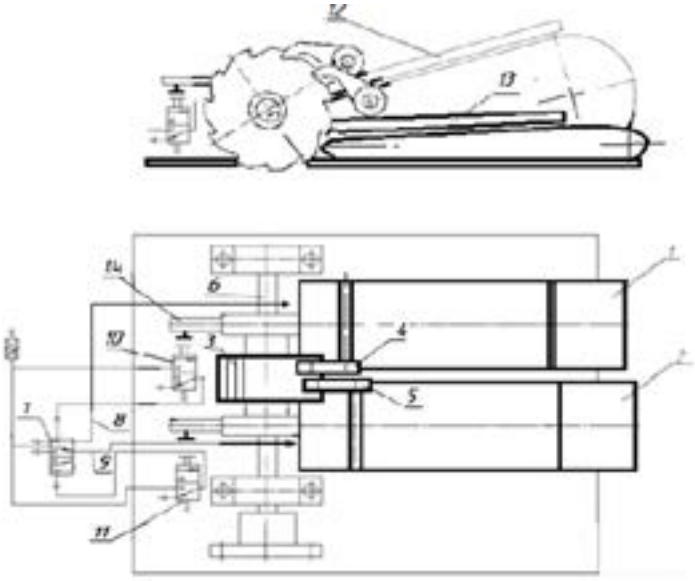


Fig. 1 - General view of a ball mill for ore grinding (BMOG)

Thus, you can make sure of the relevance of using an auxiliary starting device, which, moreover, can be used during the repair work of rotary equipment. Since the BMOG is operated in hydrometallurgical shops, it is advisable to use pneumatic drives.

As part of the research carried out at the Department of Technological Machines, Transport and Logistics, a pneumatic chamber drive (Figure-2) was developed on the basis of a rubber-cord chamber system [13, 18-21].



1, 2-rubber-cord casings (chambers); 3-ratchet wheel; 4, 5-pushers; 6-drive shaft; 7-air distributor (valve); 8,9-lines for supplying compressed air to the chambers; 10,11-pneumatic switches; 12,13-levers, 14-detent.

Fig.2-Pneumatic chamber drive and simplified control diagram

The pneumatic chamber drive consists of the rubber-cord casings 1,2 installed under the levers 12, 13, the ratchet wheel 3 and 2 pushers 4,5 mounted on the necks of rods fixed on the blades mounted on one drive shaft 6. Continuous rotation of the shaft was mounted on the ratchet wheels 3 are provided with the air distributor 7 connected by pipelines 8 and 9 with cavities of rubber-cord casings. The valve of the air distributor 7 is driven by compressed air supplied from pneumatic limit switches 10 and 11 installed on the opposite side of the rubber-cord casings. In order to prevent excessive saturation of the rubber-cord casing with compressed air, we regulate the compressed air pressure in them separately from the control system, since 0.15 MPa is enough to fill the rubber-cord casing in our case, and a little more to switch the air distributors (the same as in the workshop pneumatic line 0.35 MPa).

The principle of operation of rubber-cord casings is the same as the developed pneumatic chamber systems of the Institute of Mining named by A.A. Skochinsky.

The pneumatic chamber drive works as follows: when pressure was applied to the rubber-cord casing (chambers) 1 through the spool air distributor 7 and pipeline 8, the lever 12, was mounted on the drive shaft 6 under which the rubber-cord casing 1 was installed, rotates the shaft 6 with the fixed on it with a ratchet wheel 3 due to a pusher 4 engaged with the teeth of the ratchet wheel. At the end of the stroke, the detent 14, was installed on the opposite side of the support sleeve of the lever 12, presses on the roller of the pneumatic switch 10. In this case, the pipeline was connected to the cavity of the spool air distributor 7, the air distributor spool was moved by connecting the pressure line 9 to the chamber 2, and the rubber-cord casing 1 was connected with the atmosphere, which leads to its emptying.

Thus, with alternate filling of rubber-cord casings (chambers) 1 and 2, the shaft turns in the same direction, providing rotation of the rotary equipment.

From this it follows that the rubber-cord chamber system, at a pressure in the pneumatic lines of up to 0.15 MPa, due to the area of the supporting surface of the wedge pneumatic chambers, makes it possible to develop significant torques on the drive shaft.

Before each start, it may be necessary to return the pushers to their original position, but there are options for installing a system for returning the pushers to the working position using small pneumatic cylinders or torsion springs.

Results

The data obtained in preliminary studies that were carried out on the model of the ratchet drive showed that thanks to this design of the pneumatic drive, it is possible to develop the necessary forces to rotate the low-speed rotary equipment. To carry out research in full size, a semi-industrial sample of a ratchet drive was made.

For installation as an auxiliary drive in the composition of the mill unit, some changes were made to the design of the ratchet drive (by means of steel threaded nozzles — to the inlet 1/2 ", to the outlet to 3/4"), pneumatically operated valves were installed, in which the springs were dismantled, and the cavities were connected to the corresponding lines. Thus, the drive control system was separated from the air supply system directly to the chambers from the compressed air source (to ensure maximum flow). The same

solution reduced the loss of compressed air (to control the pneumatic valves, nozzles with a diameter of 8 mm were used). Figure 3 shows an element-by-element diagram of the ratchet drive control [17].

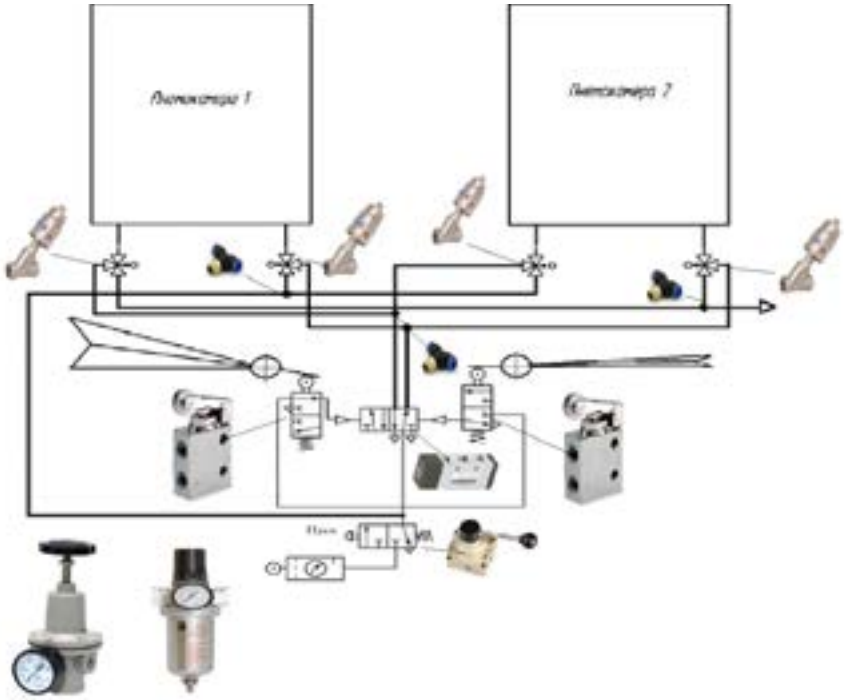


Fig.3 - Element diagram of pneumatic chamber drive control

As mentioned earlier, for heavy start-up conditions (and for bulky equipment), the ratchet drive must be provided with sufficient force to propel this type of equipment. This implies that, in the foreground, the torque developed by the ratchet drive is highlighted, which should provide both the rotation of the drum during repair work, and the choice of backlash and even a slower rotation when starting the mill [10].

To determine the torque, it is necessary to calculate the moment of resistance to rotation of the mill:

$$M_{сопр} = M_{тр} + M_{ин};$$

From the beginning, we calculate Mtr - the moment from friction in the support bearings, Nm;

$$M_{тр} = 0{,}5 \cdot f \cdot P \cdot d_n^2 \cdot l_n = 0{,}5 \cdot 0{,}1 \cdot 432\,900 \cdot 0{,}9^2 \cdot 1{,}1 = 192\,857 \text{ Н} \cdot \text{м};$$

where f is the coefficient of sliding friction on babbitt, f = 0.04 ÷ 0.1;

P - specific pressure in the bearing, Pa;

$$P = \frac{0{,}5 \cdot F}{d_n \cdot l_n} = \frac{0{,}5 \cdot 800\,000}{(0.3 \cdot 2{,}8) \cdot (0{,}25 \cdot 4{,}4)} = 432\,900 \frac{Н}{м^2};$$

d_n and l_n – diameter and length of the journal bearing, (d_p = *0.3 D;* l_p = *0.25L*), m;

D - diameter of the mill drum, 2.8 m;

F - weight of the drum of mills most common at MMC, 80 tons.

The next indicator Min is the moment from the inertial forces during the start-up of the mill drive, it is approximately 40 % of the moment of friction forces, Nm.

$$М_{ин} = 0{,}4 \cdot 192\,857 = 77\,142 \text{ Н} \cdot \text{м}.$$
$$М_{сопр} = М_{тр} + М_{ин} = 192\,857 + 77\,142 = 269\,900 \text{ Н} \cdot \text{м}.$$

Then, taking into account the gear ratio of the open gear transmission i = 10, we determine the torque on the drive shaft of the auxiliary drive, usually installed on the opposite side of the synchronous motor, should be at least 26.9 kN · m.

The ratchet drive on the basis of a rubber-cord chamber system, developed within the framework of Scientific Research Work (SRW) carried out at the department, allows, at a pressure in pneumatic lines of 0.35 MPa and an area of the bearing surface of wedge pneumatic chambers S = axb = 50x100 = 5000 cm2, to develop torques on the drive shaft up to 105 kN m (Fig. 2). It follows from this that 0.15 MPa is sufficient to drive the mill drum. Considering the bearing surface area of the wedge air bladders, it is reasonable to assume that the compressed air pressure can vary by up to 10%.

Taking into account the problems associated with the operational reliability of the mill units, it can be concluded that a ratchet drive can be used as an auxiliary drive, which would significantly reduce the starting currents on the main drive and downtime during relining.

Conclusion

A significant part of scientific research carried out in recent years in the world is mainly aimed at wider application of the capabilities of a variable frequency drive (VFD), optimization of start-up parameters and modernization of an auxiliary electromechanical drive. The analysis of the proposed technical solutions showed their high relevance, but the complexity of the frequency control system and the exponential law, which is subject to the failures of elements of this kind of drives, limit the scope of their application at small ore processing enterprises. Upgrading a standard electromechanical drive may not be worth the investment.

In this research, the possibilities of using a pneumatic chamber ratchet drive as a starting-auxiliary drive for ore-grinding units are considered. A design of an auxiliary starting device is proposed, which is distinguished by its simplicity of design and the possibility of manufacturing it by the repair and mechanical base (RMB) of the enterprise. The research results confirm the possibility of using this design. In addition, in the proposed model, in contrast to the already known auxiliary drives, the energy of compressed air will be used. Thus, this advantage greatly facilitates the process of its implementation, since in all shops of mining and metallurgical enterprises there is a distribution of highways with compressed air.

In particular, this is the first, as far as we know, research on the study of pneumatic chamber drives for their use as a starting and auxiliary drive for ore grinding units.

The results of the study provide evidence of the operability of the developed and investigated design of the auxiliary starting drive, as which a pneumatic chamber ratchet drive was used. However, there are some limitations worth noting. Although our research was carried out on a laboratory model, semi-industrial tests of this design were not carried out. Future work, therefore, should include industrial tests designed to assess the reliability and operability of the structure, directly on ore-grinding units, for example, ball mills.

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